295555 - 295EQ031 - Waste Resource Technologies

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 713 - EQ - Department of Chemical Engineering
Academic year: 2019
Degree: MASTER'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2019). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: English

Teaching staff

Coordinator: Vicenç Martí
Others: Vicenç Martí, Jose-Luis Cortina, Ignasi Casas

Opening hours

Timetable: Students have to send an email to the coordinator or to the professor to fix a meeting.

Prior skills

Language of instruction is English.

Degree competences to which the subject contributes

Specific:

CEMUEQ-06. Design, build and implement methods, processes and facilities for the integral management of supplies and residues, solid, liquid and gaseous, in industries, with the capacity to assess their impacts and risks
CEMUEQ-02. To design products, processes, systems and services of the chemical industry, as well as the optimization of others already developed, taking as a technological base the various areas of chemical engineering, including processes and transport phenomena, separation operations and engineering of chemical, nuclear, electrochemical and biochemical reactions
CEMUEQ-05. To manage and supervise all types of facilities, processes, systems and services of the different industrial areas related to chemical engineering

Generical:

CGMUEQ-02. To conceive, project, calculate and design processes, equipment, industrial facilities and services, in the field of chemical engineering and related industrial sectors, in terms of quality, safety, economy, rational and efficient use of natural resources and environment conservation
CGMUEQ-03. To lead and to manage technically and economically projects, facilities, plants, companies and technology centers in the field of chemical engineering and related industrial sectors

Transversal:

02 SCS. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
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Teaching methodology

The following activities will be carried out, either in or outside the classroom, in the development of the course:

1. Lectures, participative sessions and problem solving sessions, visits (VIS)
2. Homework and assignments (HOM)
3. Project base learning (PRO)
4. Mid-term exam (MEX) and final Exam (FEX)

Detailed project information regarding the scope, content, format, deadlines, etc., will be presented in an attached document.

Learning objectives of the subject

At the end of the course the student will be able to:

- Identify each typology of waste, its hazard and understand the kind of resources that will be obtained
- Identify and apply the proper kind of management (reduction, reusing, recycling, recovery, treatment, disposal) to optimize resources
- Preliminary design of equipment and installations for the conversion of waste in resource

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>42h</th>
<th>28.00%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>12h</td>
<td>8.00%</td>
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<tr>
<td></td>
<td>Guided activities:</td>
<td>0h</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>96h</td>
<td>64.00%</td>
</tr>
</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>1- Waste concepts, scientific basis</th>
<th>Learning time: 11h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> Hazardous and non-hazardous wastes. From linear model to circular economy. Waste Framework Directive. Hierarchy of waste management (reducing, reusing, recycling, recovery, treatment, disposal). Type of wastes linked to its origin (urban, industrial, agricultural, forestal and farm wastes, construction, mining, sanitary and specific) and impact on environment. European List of Wastes. Scientific basis for waste to resource calculation.</td>
<td></td>
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<tr>
<td><strong>Specific objectives:</strong> Fundamentals of knowledge about wastes.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>2- Waste Characterization</th>
<th>Learning time: 11h</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description:</strong> Characterization linked to determination of resource materials, hazard classification and management of waste. Analytical methods for wastes.</td>
<td></td>
</tr>
<tr>
<td><strong>Specific objectives:</strong> Knowledge of the waste characterization for its identification, classification and its management.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>3- Reducing, reusing and recycling strategies</th>
<th>Learning time: 13h</th>
</tr>
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<tbody>
<tr>
<td><strong>Description:</strong> Initiatives for reducing, reusing and recycling. Urban waste generation and collection systems. Contaminant waste. Circular economy cycles and indicators for wastes and collection fraction.</td>
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<tr>
<td><strong>Specific objectives:</strong> Highlight the application of these strategies vs other following the management hierarchy.</td>
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</tbody>
</table>
### 4-Treatment for recovery

<table>
<thead>
<tr>
<th><strong>Learning time:</strong></th>
<th>28h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>8h</td>
</tr>
<tr>
<td>Practical classes:</td>
<td>2h</td>
</tr>
<tr>
<td>Self study:</td>
<td>18h</td>
</tr>
</tbody>
</table>

**Description:**

**Related activities:**
Visit/Seminar (VIS)

**Specific objectives:**
To know the basis of treatment methods for the recovery of material that imply design of equipment and installations for the conversion of waste in resource.

### 5-Treatment of hazardous wastes

<table>
<thead>
<tr>
<th><strong>Learning time:</strong></th>
<th>25h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes:</td>
<td>8h</td>
</tr>
<tr>
<td>Practical classes:</td>
<td>2h</td>
</tr>
<tr>
<td>Self study:</td>
<td>15h</td>
</tr>
</tbody>
</table>

**Description:**
Fundamentals of mechanical separation, stripping, vapour extraction, adsorption, chemical and advanced oxidation, supercritic fluid extraction, membrane processes, stabilization, thermal desorption, vitrification, thermic, plasma, and other techniques for the elimination of hazardous components of a waste. Air pollution control systems.

**Related activities:**
Mid-term Exam (MEX) of cumulative topics 1-4.

**Specific objectives:**
To know the basis of treatment methods for the elimination of hazardous components (design of equipment and installations).
6-Waste to fuel and waste to energy

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<thead>
<tr>
<th>Learning time: 23h</th>
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<tbody>
<tr>
<td>Theory classes: 6h</td>
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<tr>
<td>Practical classes: 2h</td>
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<tr>
<td>Self study: 15h</td>
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</tbody>
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**Description:**
Biogas (anaerobic digestion plants from biowaste), pyrolysis, gasification, plasma arc. Refuse derived fuel. Description of techniques and installations of combustion/incineration/cogeneration. Fuel cells based on wastes.

**Related activities:**
Homework and Assignements (HOM)

**Specific objectives:**
To know the basis of treatment methods for the recovery of energy and energetic products from wastes

7-Waste Disposal

<table>
<thead>
<tr>
<th>Learning time: 13h</th>
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<tbody>
<tr>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td>Practical classes: 1h</td>
</tr>
<tr>
<td>Self study: 8h</td>
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</tbody>
</table>

**Description:**
Type of landfills used for different wastes (construction, inert, non-inert, special), design of landfill. Biogas and lixiviates and its management. Incineration for the elimination of hazardous wastes. Urban mining.

**Related activities:**
Homework and Assignements (HOM)

**Specific objectives:**
Knowledge about the management of waste to landfilling and destined to incineration to eliminate hazardous compounds.

8-Special waste topics

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<tr>
<th>Learning time: 26h</th>
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<tbody>
<tr>
<td>Theory classes: 6h</td>
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<tr>
<td>Self study: 20h</td>
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</table>

**Description:**
Fundamentals on radiation, wastes of low, medium and high activity, nuclear power plant impact, type of storage (ATC, AGP, low activity). Reprocessing of nuclear fuel. Basis of Human Health Risk Assessment. Examples of specific management of case study wastes from the Project (PRO) activity.

**Related activities:**
Project based learning (PRO)

**Specific objectives:**
To have the basis of radioactive waste management and processing as well as Human Health Risk Assessment. To know case studies of waste management based in the technologies learned in (PRO) activity.
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Planning of activities

| Visit to waste manager/ attendance to seminar (VIS) | Hours: 4h  
Guided activities: 2h  
Self study: 2h |
|--------------------------------------------------|-------------|
| Description:  
The activity will supply direct information from companies/professionals linked with the treatment of wastes to recovery. The visit/attendance to the seminar will be evaluated with a questionarie. |

| Mid-term exam (MEX) | Hours: 50h  
Guided activities: 2h  
Self study: 48h |
|---------------------|-------------|
| Description:  
Mid-term exam will be an exam of the first part of the subject and capacity of the student to assimilate initial concepts. |

| Project base learning (PRO) | Hours: 12h  
Guided activities: 2h  
Self study: 10h |
|----------------------------|-------------|
| Description:  
The teachers will suggest a list of waste management topics to develop as a project in groups of 3-5 students. The students have to look for case studies that match with the demand and elaborate a report detailing this info and perform a presentation in the "Special topics" session to the audience |

| Homework and assignements (HOM) | Hours: 4h  
Self study: 4h |
|---------------------------------|-------------|
| Description:  
Individual activity based in solving some exercices or perform simulations using soft at home. |

Qualification system

The final grade is determined according to the following equation:

Final grade = 0.20*MEX + 0.50*FEX + 0.1*(HOM+VIS+PRO)

Regulations for carrying out activities

Mid-term exam and final exam performed with the use of class notes and ATENEA material.
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Bibliography

Basic:


Complementary:


Others resources:

Guidance documents from USEPA (https://www.epa.gov/) and other EPA.
Guidance documents from Ellen MCArthur Foundation (https://www.ellenmacarthurfoundation.org/)
Legislation for EC (http://ec.europa.eu/environment/waste/index.htm)
Other web-based information.